Weather Network Defends Texas Water Tables

By Terry Howell, Thomas Marek, Leon New and Don Dusek

Irrigation is the largest use of water in the Texas High Plains, a region with more than four million acres of irrigated crop production. In just the northern 26 counties of the Texas Panhandle, a region called the Amarillo trade area, the annual crop production receipts exceed $770 million. The estimated agribusiness impact exceeds $3.25 billion (Amosson and Ledbetter, 1996). This region depends on the Ogallala aquifer for the majority of its water supply, but this incredible water resource is declining.

Despite enormous changes in irrigated agriculture in the past 20 years that have dramatically decreased the water applied per unit land area, some areas in the region are still experiencing water table decline rates that exceed two feet per year. At the USDA-ARS station at Bushland, most of our well hydrographs now show water table decline rates less than one foot per year. However, well yields have declined appreciably as the aquifer saturated thickness has decline.

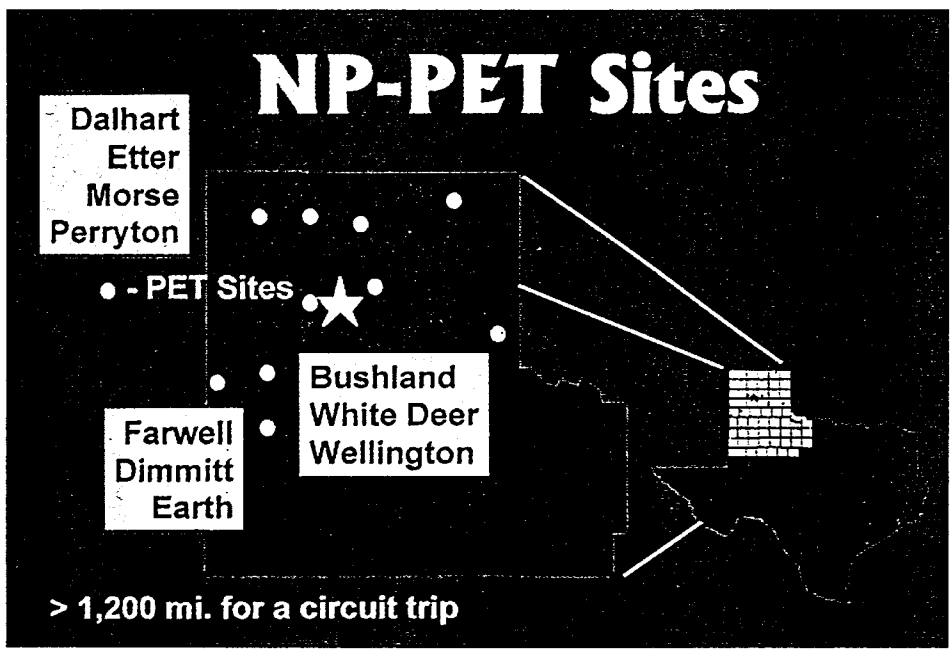
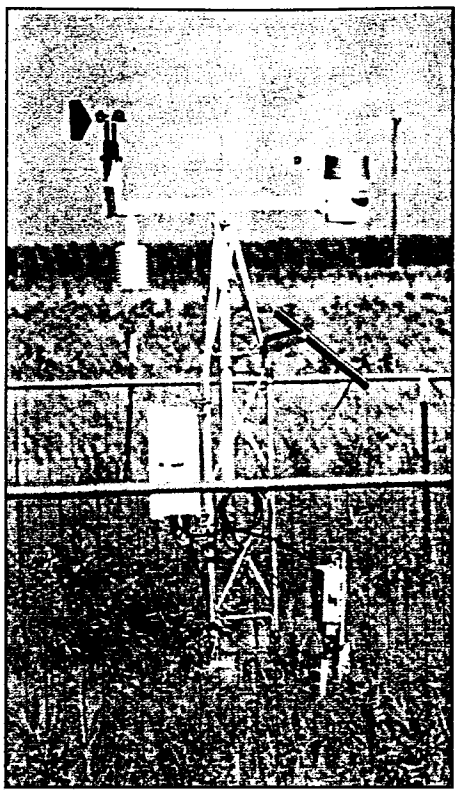


Figure 1. NP-PET Sites. Data from each site is received every night. Results are faxed to farmers by 6 a.m.



One of ten weather stations located across the central and northern Texas Panhandle.

Many areas, such as the James Bush Farm just north of Bushland, still experience water table decline rates that exceed two feet per year. Other areas have even larger aquifer depletion rates. Advanced irrigation scheduling is one technology not widely used in the Texas High Plains that can further reduce irrigation applications and help sustain irrigation ion this important region.

Weather Station Network Established

In 1992, a Texas Agricultural Experiment Station and Texas Agricultural Extension Service team at Lubbock (Seymour et al., 1994) developed the South Plains PET Network around the three weather stations at Lamesa (AgCares), Lubbock and Halfway. They faxed daily PET (Potential Evapotranspiration) and heat unit information to subscribers and distributed it to mass media. They developed spreadsheet programs to use these data for irrigation scheduling and extensively worked

on education and training of growers to use this technology.

During 1994, a Texas Agricultural Experiment Station, Texas Agricultural Extension Service and USDA-ARS team at Amarillo/Bushland/Etter (Marek et al., 1996) developed a similar weather station network. It was called the NP-PET Network, to serve the northern Texas Panhandle. The team sought input and feedback from growers and crop/irrigation consultants prior to finalizing delivery and format.

The NP-PET currently operates ten separate weather stations across the central and northern Texas Panhandle. Although these two networks are separate and distinctly different, they collaborate and use similar methods. The NP-PET network sends more than 325 faxes each night to a wide range of subscribers. Both networks maintain a Web site where the faxes and archived data can be located. Hourly data and daily statistics (maximums, minimums, totals, etc.) are available on the Web site.

Another similar network was developed in 1995 by Guy Fipps at Texas A&M University. This network serves more than 12 station sites from the Lower Rio Grande Valley to the Coastal Bend and Edwards aquifer regions to north and central Texas. Other networks are in Texas and surrounding states. The Oklahoma Mesonet (Brock et al, 1995, and Elliott et al., 1998) may be the most extensive example. Plans are underway for a Texas Mesonet for more complete electronic statewide weather information coverage.

Table 1. Example Fax Sheet

North Plains PET Network **Weather Station, Farwell, TX**

		Temperatures (F)				Growing Degree Days (F)						
Date	PET in.	Air Max./Min.	Soil 2 in.	Min. 6 in.	Prec. in.	Crn	Srg	Pnt	Cot	Soy	Bet	Wht
4/22/98	.18	72/35	49	53	0.00	11	0	9	0	0	16	22
4/23/98	.27	85/41	51	55	0.00	17	0	15	0	0	23	28
4/24/98	.37	89 43	55	58	0.00	18	0	17	0	0	26	29
10-day avg min soil temp			48	53								

CORN		Short Season Var. Water Use					Long Season Var. Water Use				
Seed Date	Acc GDD	Growth Stage	Day	3day	7day	Seas. in.	Growth Stage	Day	3day	7day	Seas. in.
			----------	in/d	----------			----------	in/d	----------	
4/01	238	Emerg	.13	.10	.07	1.5	Emerg	.13	.10	.07	1.5
4/15	88	Seed	.09	.07	.05	0.5	Seed	.09	.07	.05	0.5

PEANUTS		Short Season Var. Water Use					Long Season Var. Water Use				
Seed Date	Acc GDD	Growth Stage	Day	3day	7day	Seas. in.	Growth Stage	Day	3day	7day	Seas. in.
			----------	in/d	----------			----------	in/d	----------	
4/15	68	Seeded	.03	.02	.01	0.1	Seeded	.03	.02	.01	0.1

WHEAT		Water Use				
Seed Date	Acc GDD	Growth Stage	Day	3day	7day	Seas. in.
			----------	in/d	----------	
8/15	4628	2nd node	.48	.35	.27	32.1
9/10	3673	1st node	.46	.35	.27	25.2
10/1	2976	Stm Elg	.46	.34	.26	16.5

NOTE—Precipitation data reported from snow and/or ice will not be accurate.

Crop abbreviations for the growing degree days are Crn (corn), Srg (sorghum), Pnt (peanut_, Cot (cotton), Bet (sugar beet), and Wht (winter wheat). Other abbreviations on this fax include Emerg. for emergence, Stm for stem, Elg for elongation, Var. for variety, Seas. for season, Min. for minimum, Max. for maximum, Prec. for precipitation, and PET for potential evapotranspiration.

ARS - BUSHLAND WEB ADDRESS — http://www.cprl.ars.usda.gov/
North Plains PET Home Page Address — http://amarillo2.tamu.edu/nppet/petnet1.htm

NP-PET Network Operation

NP-PET sites are shown in *Figure 1*. The northern tier of stations are located at Dalhart, Etter, More and Perryton. The central tier of station are located at Bushland, White Deer and Wellington, with the southern tier of stations at Farwell, Dimmitt and Earth. NP-PET computers are located at Bushland. They call each station after midnight to acquire the weather data from the previous day.

The computers process the data, computing PET, heat units (growing degree days of GDDs), and the crop water use for corn, cotton, wheat, sorghum, soybean and peanut. These data are used to format a fax sheet for each weather station and its associated crops. Some stations only have certain crop data segments.

Next, the computers automatically send the fax sheets to each subscriber for that station before 6 a.m. A fax log file helps find any nightly errors and can verify when each fax was sent. The computers upload the fax files and the hourly processed weather data files to a central server for access on the world wide web (**http://amarillo2.tamu.edu/nppet/petnet1.htm**).

Table 1 illustrates a daily fax sheet sent on April 25, 1998, for the Farwell NP-PET weather station (see http://amarillo2.tamu.edu/nppet/data/new/farwell/dailyfax/). On this date, only data on wheat, corn and peanuts are reported. Cotton and soybean data began appearing on

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May 1 and May 15, respectively.

The upper section gives a mini three-day climate summary with the daily PET value, maximum and minimum air temperatures, minimum soil temperatures for the two and six inch depths, precipitation and GDDs for various crops. The 10-day average minimum soil temperatures are also given as a crop planting guide.

The middle sections give specific data for each crop (in season) that we report for that specific weather station site. Each crop's water use is bracketed for four planting dates that generally cover the expected range in planting dates. The accumulated GDDs from sowing until the current day are given for each sowing date, along with a predicted crop development stage. Also provided is average daily ET rates for the current day, past three days and past seven days — as well as the accumulated season water use (ET).

For corn, sorghum and peanuts, water use and development are estimated for two types of typical long and short-season cultivars (hybrids for corn and sorghum, varieties for peanuts). In the case of cotton, wheat and soybean (mid group IV type), only one cultivar type is simulated. We only simulate "well-watered" and "normal" crops (no insect, disease or weed pest limitations) for a "high level" production practice.

The bottom section contains a limited space for remarks, messages, notices and alerts. The notices on this fax sheet highlight our Web site addresses and our "standard winter disclaimer about the measured precipitation. Our rain gauges are not capable of accurately recording snow and/or ice.

Detailed Data Available

Many users require more detailed data for their particular applications, especially consultants and industries that may be using models. Therefore, all the NP-PET hourly data (as well as the fax sheets) are available on the Amarillo Agricultural Research and Extension Center Web server (http:amarillo2.tamu.edu/nppet/petnet1.htm). These data and fax files are updated daily, compacted into 10-day zip files to save space and speed up downloading.

All the NP-PET data are measured and recorded in the System International (S.I.) unit system for integrity and consis-

tency. The fax sheets are presented in English units. Conversion factors into common English units are widely available. We can also assist with any specific questions.

The file header gives station data and standard astronomical data for that day. Data columns represent hourly means (or an hourly total for precipitation) of the data and derived parameters. The bottom section contains daily sums (an integrated value for solar radiation), daily averages, and maximums and minimums and their time of occurrences for specific column variables.

If you look back at *Table 1*, you will notice a dramatic increase in PET for 0.27 to 0.37 inch per day on April 23 and April 24. A PET value of 0.37 inch per day is fairly large but not uncommon for West Texas.

Karl Johnson of Morse, TX irrigates sorghum field with surge valves and PET data.

The air temperatures were only a little warmer on April 24 (see Table 1), and the amount of solar radiation (sunshine) was similar to the previous day. The main differences between the two dates can be seen in the mean relative humidity and wind speed. Our data and experiences have illustrated that such occurrences are not uncommon in this region, but they can greatly impact water management decisions in the spring.

The ARS ET team at Bushland has measured and documented many extremely high ET rates for wheat, corn, alfalfa and grass that are as high as any place in the world. These extreme ET rates often occur in spring and early summer in the Texas High Plains. During these times wind speed is stronger, the air is drier, and the skies are clearer than the summer months.

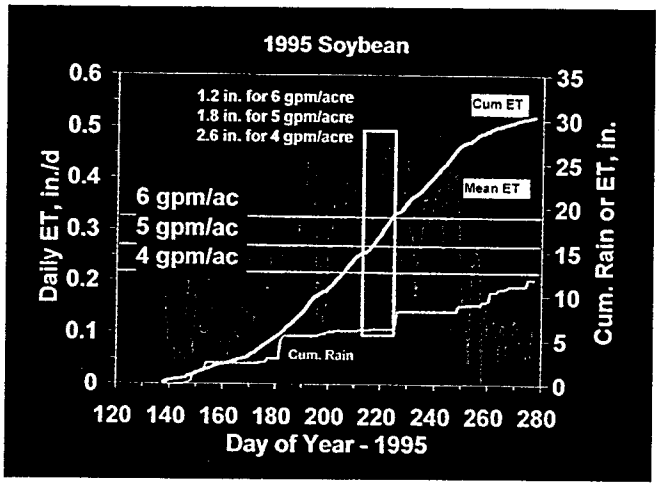

Figure 2 illustrates the importance of maintaining irrigation capacity to meet most of ET demand.

Using the NP-PET Information

To use the information from NP-PET, considerable training and/or continuing education is needed. The Texas Agricultural Extension Service, Texas A&M University and West Texas A&M University all extensively use the PET data in training and education. At a minimum, local data on field and rainfall are needed. Other necessary data include the field system capacity (flow rate per unit area) and/or the gross flow rate and estimate of "application efficiency." These data require recent pump testing — perhaps even some irrigation system performance verifications.

Crop data on sowing date and hybrid dates are also needed. It is probably better to match the actual crop development status in your field with the fax sheet crop growth stage, rather than relying solely on your sowing date.

Figure 2 gives an example for a 1995 soybean crop. Only three significant rain events occurred for the whole season from planting through August, although many smaller and less significant rains occurred. To avoid crop water deficits and yield reductions, the difference between the rain and ET must come from irrigations or previously stored soil water. Irrigations should be applied to replenish the rootzone to a relatively full soil profile by the time when crop development reaches a critical period — like flowering and pod development for soybeans.

Focus on the three weeks in August, centered at about day of year 220, within the box. If six GPM/acre irrigation capacity was available, a deficit of 1.2 inches would develop during this period. And if the irrigation capacity was reduced to five or four GPM/acre, the deficit would increase to 1.8 and 2.6 inches respectively during this one period.

These deficits would have to be drawn from soil water or the crop would suffer water deficits and reduced yields. This simple example illustrates the critical importance of maintaining irrigation capacity that meets the majority of the ET demand in order that some flexibility in irrigation management can be achieved.

Although many irrigated areas have irrigation capacities that more than meet near maximum ET rates, most of the western Ogallala regions stretch their well capacities. If a marginal irrigation capacity is used, then a producer is always trying to catch up and needs timely rains to obtain an acceptable yield. By knowing the crop ET requirements (and as we obtain longer-term data better describing the "expected or normal" ET rates and its expected probabilities), growers and consultants will be in a much better position to make critical and strategic irrigation decisions. They will also be able to determine their acceptable levels of risk.

Network is a Team Effort

The NP-PET network requires a collaborate effort and support from many agencies and people. Grants come from the Corn Producers Board; Texas Wheat Producers Board; High Plains Underground Conservation District No. 1; North Plains Ground Water Conservation District No. 2; Panhandle Ground Water Conservation District No. 3; Collingsworth County Underground Water Conservation District; and from other agencies (USDA-NRCS) and individual producer groups. The multi-agency personnel involved with the NP-PET network are the following: Texas Agricultural Experiment Station — Thomas Marek and Gerald Michels, Jr.; TAES — Leon New and Brent Bean; USDA-ARS — Terry Howell, Steve Evett and Don Dusek. At Bushland, all the Water Management Research Unit personnel are involved with developing the ET data upon which the NP-PET network is based. Arland Schneider, Judy Tolk, Karen Copeland, Jim Cresap, Keith Brock and Brice Ruthardt also contribute.

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